High spatio-temporal resolved light-driven merging of microdroplets in microfluidic chambers

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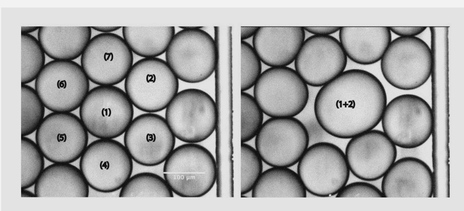
Summary : The merging of selected droplets is surfactant dependent and can be realized either by using passive or active strategies. Active fusion can be achieved through the use of external high voltage and/or a pair of micro-electrodes. Active merging of microdroplets can be realized by using light. This approach is particularly attractive since light provides flexibility and wavelength/intensity tunability and may be realized in high temporal and spatial resolution

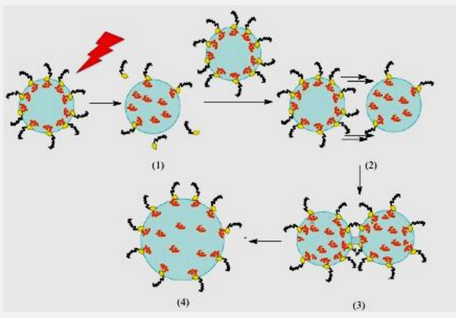
Introduction

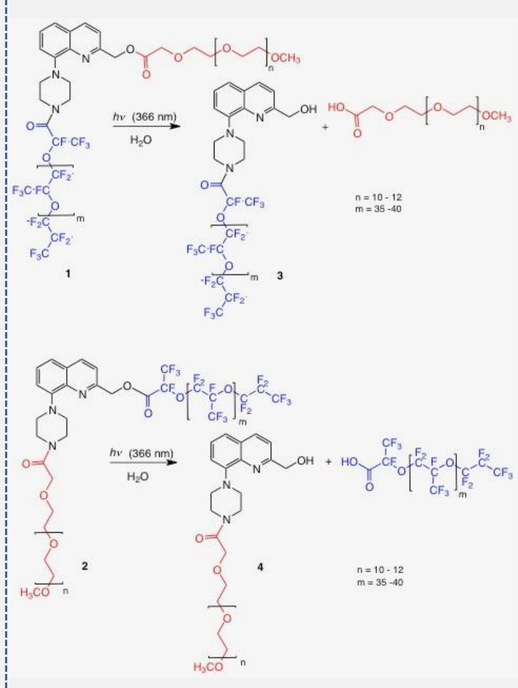
- Active merging of microdroplets is one of the most important manipulations enabled by droplet-microfluidics, as it enables for on demand droplet targeting and sequencing of complex chemical and biological reactions.
- We developed recently two new optofluidic approaches, which overcome such limitations and allow for a rapid controlled coalescence of targeted microdroplets thanks to the application of a ps UV pulsed laser.
- Our first approach is based on the photolysis of aminoquinoline-derived photosensitive surfactant [1], while the second is based on the photo-isomerization process of another azobenzene-derived surfactant [2].

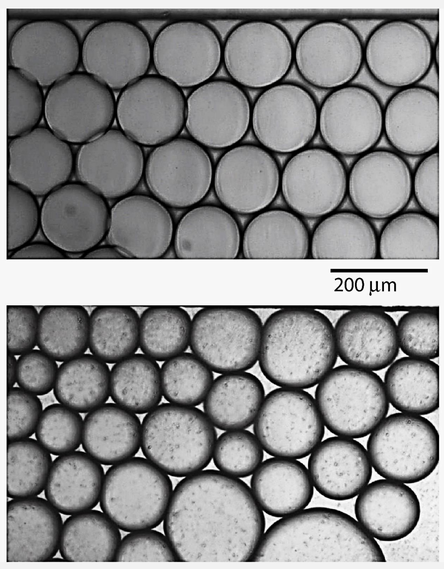
Photolysis of microdroplets [1]

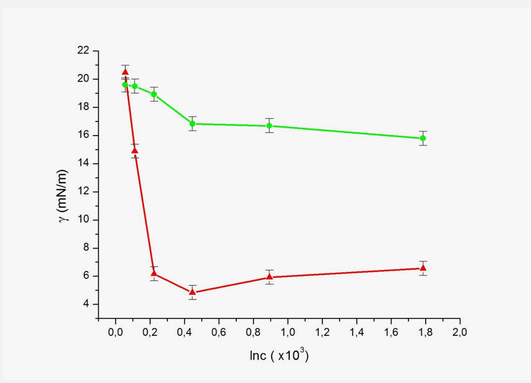
Stabilized by aminoquinoline-derived photosensitive surfactants composed of polyethyleneglycol/perfluorinated polyether (PEG/PFPE) diblock amphiphiles by using 355 nm ps pulsed laser light, resulted in rapid controlled coalescence of targeted microdroplets offering the prospect of a novel type of droplet merging with high stereospatial integrity for microfluidic systems.











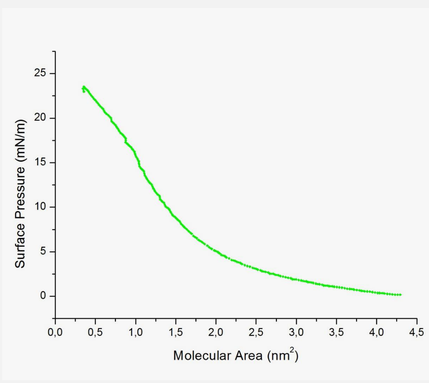
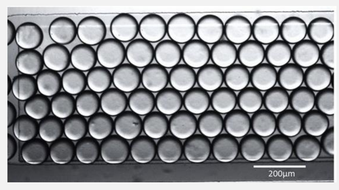
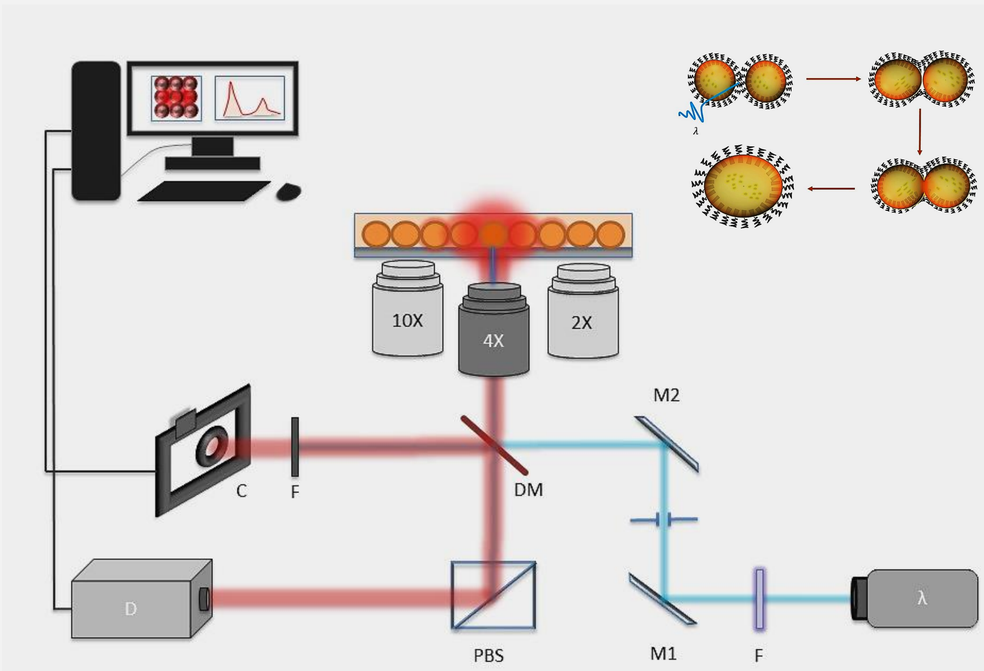
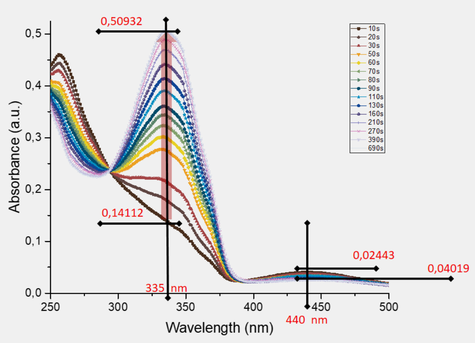


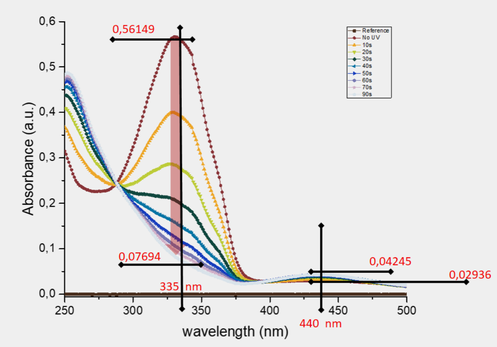
Photo-isomerization of Surfactant [2]

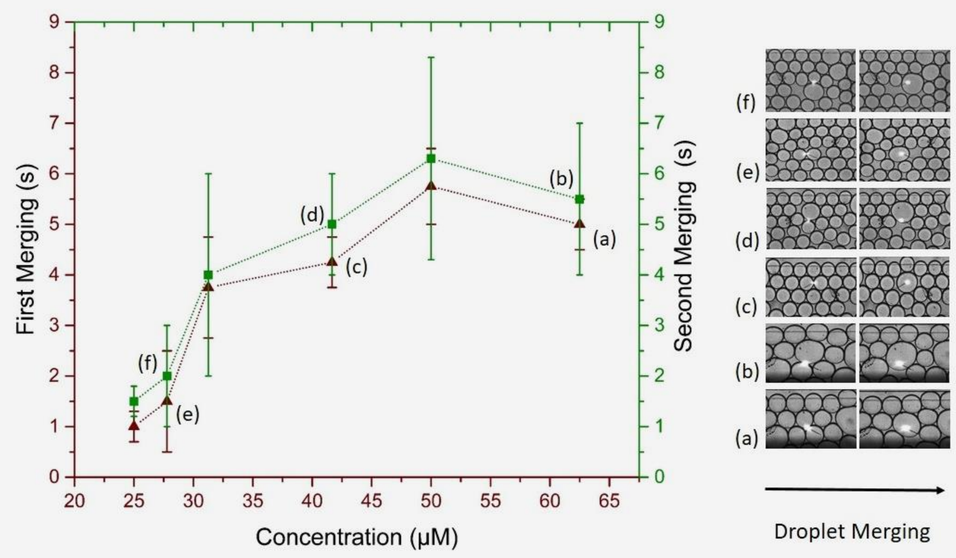
The mechanism governing the light driven merging of droplets using photo-isomerisation is based on a subtle opto-mechanical process induced by the dynamical switching between the trans and cis photo-isomers under UV laser illumination.











[1] P. Dunkel, Z. Hayat, A. Barosi, N. Bchellaoui, H. Dhimane, P. Dalko, and A. El Abed, "Photolysis-driven merging of microdroplets in microfluidic chambers," Lab Chip 16(8), 1484 (2016).
[2] Z. Hayat, C. Deo, R. Métivier, N. Bogliotti, J. Xie, M. Buckle and A. El Abed, "High spatio-temporal resolved merging of microdroplets in microfluidic chambers driven by the photo-isomerisation of an azobenzene derivative surfactant", (submitted to Lab Chip).

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